CLAIMS

1.- Phase-shifter (200) comprising a first waveguide (201) and a second waveguide (202), the first waveguide (201) varying between a first width (w1) and a second width (w3), characterized in that the first waveguide (201) comprises a first delay (221) with the second width (w3), and the second waveguide (202) comprises a second delay (222) with a third width (w4), the first delay (221) and the second delay (222) comprising arrangements of periodically alternated sections of the core material and of the cladding material, with a period smaller than a value of the shortest wavelength in the bandwidth of the phase-shifter (200).

2.- Phase-shifter (200) according to claim 1, characterized in that the phase-shifter (200) further comprises a plurality of mode adapters (220, 222, 230, 232) progressively varying waveguide width while periodically alternating sections of a core material and of a cladding material.

3.- Phase-shifter (200), according to any one of the preceding claims, characterized in that that the phase-shifter (200) comprises at least one phase-loading waveguide segment (250) located at a side of the first waveguide (202) and extending parallel thereto.

4.- Phase-shifter (200), according to claim 3, characterized in that the at least one phase-loading waveguide segment (250) comprises a region with periodically alternating sections of the core material and of the cladding material.

5.- Integrated mode converter and multiplexer, comprising:

- at least a first monomode input waveguide (401) adapted to receive a first input zero-order signal (410) and a second monomode input waveguide (402) adapted to receive a second zero-order signal (420);

- a multimode output waveguide (501) adapted to transmit at least a first zero-order output signal (510) and a second first-order output signal (520); and
- a multimode interference coupler (100) configured to equally split optical signals from a first input (101) and a second input (102) into a first output (111) and a second output (112), and to induce a first phase shift of 90º between the first output (111) and second output (112);

characterized in that the mode converter and multiplexer further comprises:

- a first phase-shifter (200) according to any one of claims 1 to 4 connected to the first output (111) and second output (112), configured to induce a second phase shift between the first output (111) and second output (112), wherein the period of the arrangements of periodically alternated sections is also smaller than a value of the shortest wavelength in the bandwidth of the mode converter and multiplexer;
- one symmetrical Y-junction (300) arranged next to the first phase-shifter (200), configured to combine outputs of the first phase-shifter (200) into the multimode output waveguide (501); and

in that the multimode interference coupler (100) further comprises:

- one region in the multimode interference coupler (100) comprising an arrangement of periodically alternated sections of a core material and of a cladding material, with a period smaller than a value of the shortest wavelength in the bandwidth of the mode converter and multiplexer; and

in that the first input (101), second input (102), first output (111) and second output (112) further comprise:

- mode adapters (130), each mode adapter (130) comprising a progressively varying waveguide width while periodically alternating sections of the core material and of the cladding material.

6.- Integrated mode converter and multiplexer according to claim 5, characterized in that:

- the first monomode input waveguide (401) is connected to the first input (101) of the multimode interference coupler (100),
- the second monomode input waveguide (402) is connected to the second input (102) of the multimode interference coupler (100), and
- the second phase shift is 90º.

7.- Integrated mode converter and multiplexer according to any one of the preceding claims, further comprising a third monomode input waveguide (403) adapted to receive a third input zero-order signal (430), and being the multimode output waveguide (501) adapted to further transmit a third output second-order signal (530), being the integrated mode converter and multiplexer characterized in that the multimode interference coupler (100) further comprises a third input (103), a fourth input (104), a third output (113) and a fourth output (114); wherein the integrated mode converter and multiplexer further comprises:

- a symmetrical Y-junction (300) connecting the second monomode input waveguide (402) to the second input (102) and third input (103);
- a second phase-shifter (200) configured to induce a third phase shift between the third output (113) and fourth output (114); and
- a third phase-shifter (200) configured to induce a fourth phase shift between the second input (102) and third input (103).

8.- Integrated mode converter and multiplexer according to claim 7 characterized in that the second phase shift is 45º, the third phase shift is 135º and the fourth phase shift is 90º.

9.- Integrated mode converter and multiplexer according to any of the previous claims, characterized in that the at least one phase-shifter (200) is a controllable phase-shifter (200), externally switched between a first phase shift value and a second phase shift value.